Critical Thinking Skills in USAF Developmental Education

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Introduction

In the September 2015 Air Force Future Operating Concept (FOC), the Secretary of the Air Force (SecAF) and the Chief of Staff of the Air Force (CSAF) identified the need for:

> . . . Airmen who display critical thinking in complex situations, are educated and trained appropriately, and ultimately are empowered and trusted to execute. . . This foundation is built by recruiting Airmen with indicated potential for critical thinking and adaptive behavior; screening for these attributes will require new metrics and forms of evaluation.[1]

However, no published or publicly available data exists to address (1) the current state of critical thinking (CT) skills in the Air Force, (2) a recommended metric by which to measure CT skills, and (3) whether the existing state of CT skills satisfies the AF FOC's intent. Using the Watson-Glaser Critical Thinking Appraisal (WGCTA), I addressed these points by focusing on the active duty (AD) AF students attending Air Command and Staff College (ACSC), School for Advanced Air and Space Studies (SAASS), and Air War College (AWC) in Academic Year (AY) 2016. These three populations within Air University (AU), through the developmental education boarding process, provided a representative sample of the top 20 percent of AD AF officers for AY16.[2] As a point of clarity, I explored the state of CT skills as an indicator for the SecAF and CSAF, not whether, or how much, AU integrated CT into the curriculums.

Since before 1997, the AF has identified CT as a key skill,[3] yet the AF has not established any metrics to provide a baseline assessment of CT. Several AF studies identified the need for CT, but the authors limited the recommendations to ways to improve CT programs without first assessing the state of CT skills.[4] This foundational study, through a quantitative methodology, provided a baseline assessment of CT skills from the sample population.

Thesis

I used the WGCTA to measure the CT skills of a sample of AD AF attending ACSC, SAASS, and AWC to establish the current baseline of CT as represented by the top 20 percent of AD AF officers in AY16. My research answered the following four research questions:

- What was the current state of CT skills as measured by the WGCTA?
- Using t-tests, were there any significant differences between all three schools?
- How did the sample's performance compare with a graduate degree normative group?
- What CT instructional methods could AU apply to in-residence professional military education?

After approaching these research questions, I could assess the following hypotheses:

- H_0—There is no statistically significant difference in the CT skills of intermediate developmental education (IDE) and senior developmental education (SDE) students.
- H_a—There is a statistically significant difference in the CT skills of IDE and SDE students.
- H_b—There is a statistically significant difference in the CT skills of ACSC and SAASS students.
- H_c—There is a statistically significant difference in the CT skills of AWC and SAASS students.

Literature Review

As identified in AF Doctrine Document 1–1, senior leaders expect Airmen to think critically: "Education provides critical thinking skills, encouraging exploration into unknown areas and creative problem solving. Its greatest benefit comes in unknown situations or new challenges; education prepares the individual for unpredictable scenarios."[5] While senior leaders in the AF and DOD frequently emphasized the need for CT, they rarely provided any refined directives defining CT skills or how these skills should be measured and developed. The lack of clear directives leaves implementation to either AU or, for those not selected to attend in-residence IDE or SDE, the individual, and with limited tools for execution. The following section details the challenges of defining the construct of CT, presenting a consensus that CT skills: (1) are the product of a personal and lifelong dedication to improving the accuracy and logic of thought patterns, and (2) can be both taught and measured. Based on a comparison of CT development programs in academic and business settings, the deliberate development of CT skills in both PME and throughout the operational AF would be possible to implement.

Concept of Critical Thinking

Definitions of CT range from abstract constructs to specific, measurable skills.[6] The National Council for Excellence in CT (NCECT) approached the definition with two components: "(1) a set of information and beliefs generating and processing skills, and (2) the habit, based on intellectual commitment, of using those skills to guide behavior."[7] In comparison, Richard Paul and Linda Elder defined CT as: "the art of analyzing and evaluating thinking with a view to improving it."[8] Lewis Vaughn provided a succinct working definition for the construct of CT: "the systematic evaluation or formulation of beliefs or statements, by rational standards."[9] Goodwin Watson and Edward M. Glaser, the creators of the survey instrument used in this study, viewed CT as:

> . . . a composite of attitudes, knowledge, and skills. This composite includes: (1) attitudes of inquiry that involve an ability to recognize the existence of problems and an acceptance of the general need for evidence in support of what is asserted to be true; (2) knowledge of the nature of valid inferences, abstractions, and generalizations in which the weight or accuracy of different kinds of evidence are logically determined; and (3) skills in employing and applying the above attitudes and knowledge.[10]

While even this small sample of available CT definitions provides additional and valuable insight, the focus remains on a systematic evaluation of an individual's thoughts by rational standards. Although simplistic, Vaughn's definition provides the best balance between the scope of the concept and being sufficiently succinct for use in everyday discussions around the AF.

While CT is a vital piece of the spectrum, it is not the only form of thinking. When discussing CT, Airmen frequently blur the lines between CT and creative thinking.[11] Both are important, and they complement one another; however, creative thinking is "resulting from originality of thought; having the ability to create or produce; having or showing imagination and artistic or intellectual inventive-

ness; stimulating the imagination and inventive powers."[12] One must create the idea before it can be scrutinized with critical thinking. The two forms of thinking work in concert, but CT focuses on systematic evaluation based on rational standards.

With this foundation for the concept of CT, one can identify skills with more specificity for purposes of direct comparison. As tested in the WGCTA, Watson and Glaser delineated the five skills of CT: inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments (see Table 1).

Table 1. Definitions of WGCTA skills

Critical thinking skill	*Definition*
Inference	Discriminating among degrees of truth or falsity of inferences drawn from given data
Recognition of assumptions	Recognizing unstated assumptions or presuppositions in given statements or assertions
Deduction	Determining whether certain conclusions necessarily follow from information in given statements or premises
Interpretation	Weighing evidence and deciding if generalizations or conclusions based on the given data are warranted
Evaluation of arguments	Distinguishing between arguments that are strong and relevant and those that are weak or irrelevant to a particular question at issue

Source: Data adapted from Goodwin Watson and Edward M. Glaser, *Watson-Glaser Critical Thinking Appraisal: Manual* (San Antonio, Texas: Psychological Corporation, 1980), 2.

Measuring Critical Thinking

Researchers have dedicated decades of study on various methodologies measuring CT. While there are somewhat intrusive and time-intensive methods where an individual has a one-on-one examination with a trained evaluator, most researchers and organizations use standardized assessment instruments. Although multiple CT tests are available,[13] the WGCTA was the most effective instrument to assess the proposed hypotheses and research questions. The WGCTA is computer-administered and has established validity and reliability, as well as normative groups based on a wide range of populations.[14] The WGCTA assesses the five CT skills through 40 multiple-choice items. Published research relying on the WGCTA is abundant, addressing the importance of CT in career fields to include emergency management, nursing, education, and intelligence.[15]

While the WGCTA itself is broken into the five CT skills, the individual test results yield three categories: (1) recognize assumptions, (2) evaluate arguments, and (3) draw conclusions. Factor analysis revealed a more repeatable and reliable assessment by combining inference, deduction, and interpretation into the category of "draw conclusions." As a new category not defined in Table 1, drawing conclusions is the act of "arriving at conclusions that logically follow from the available evidence."[16]

Professional literature, as well as the research reported in the test manual, established the psychometric qualities of reliability and validity for the WGCTA.[17] For internal consistency reliability coefficients and Standard Errors of Measurement, the

WGCTA scored a 0.83 and 2.63, respectively.[18] The two versions of the WGCTA available for pre- and post-testing options in educational and developmental programs provided split-half reliability as well.

Watson and Glaser examined the WGCTA's validity in several settings with different populations. The graduate degree normative group applied for comparison in this study consisted of 2,321 participants ranging across 38 occupations to include entry-level positions, government service, and executive leadership. Across the dozens of normative groups, with sample sizes reaching 1,699,[19] WGCTA participants at various levels and across several lines of study performed in a manner to lend criterion validity to the multiple attempts to develop CT skills in any environment.[20] Watson and Glaser assessed the construct validity, including content validity, internal factor structure, and convergent and discriminate validity, with supportive results.[21] The established psychometric qualities of the WGCTA make it a useful measuring instrument for research and programs exploring the development of CT.

Given the amount of time and research required to create and validate a survey instrument, the military should use an existing tool to measure CT.[22] AF leaders must remember the WGCTA is a single assessment and is not suitable as the sole metric for identifying critical thinkers. Some critical thinkers may possess different modalities of thinking that does not effectively translate to the WGCTA's measurement. As with any assessment of an Airman, the AF must consider the supervisor's assessment and the individual's performance.

Improving Critical Thinking through Deliberate Development

Upon measuring CT in a population, several participants will likely want to explore different ways to improve those skills. The initiative to develop CT is a legitimate endeavor for all Airmen as these skills are not static.[23] One study comparing the development of CT skills across different age groups found that "adult students do not appear to be dramatically different from their younger counterparts in terms of their reflective thinking, including their epistemic assumptions and the way they justify their beliefs in the face of uncertainty."[24] The development of CT should not be limited to just the brand-new officers and enlisted on the flight line or to the strategic-level thinkers in the Pentagon, and this development must be accomplished with the right instructors.

The importance of selecting the right faculty. When creating a CT program, the organization must know which individuals are critical thinkers before determining the faculty. Lois Magnussen's research in a nursing program suggested the CT skills of graduating students correlated with the CT skills of the instructors, even to the point of fault.[25] Students with low scores improved to approximate the instructors' CT scores and students with scores already similar to the faculty's remained roughly the same. The concerning portion of the research was the fact that the students initially scoring high in CT skills dropped and became average through the course of the multiyear program. Per Laurie Blondy, significantly higher CT skills for a nursing school faculty, when compared to the students, were critical to the success of CT development.[26] In a similar study, there were parallel themes in the difference

of CT skills between uniformed police and police cadets.[27] Finally, tutors in a successful WGCTA test preparation program for teachers scored significantly higher than the students did.[28] The significant differences between the instructor and student scores in these studies suggested a successful program require a faculty with strong CT skills, and additional research conducted as part of this project suggested the talent for a successful program was already in existence at AU (see Implications).

The flexibility of the human mind. CT is not a static item such as one's intelligence quotient. Instead, people can improve CT skills at any age.[29] Conversely, CT skills are also perishable and can deteriorate if the individual does not dedicate oneself to their maintenance and improvement over time.[30] Jennifer Reed explored the potential to develop CT skills, concluding, "students in the experimental group performed at a statistically significantly higher level than students in the control group."[31] Reed also determined "age and gender do not appear to play significant roles in developing college students' critical thinking abilities."[32] David T. Moore's research[33] indicated life experience does not necessarily directly correlate with improved CT skills in the intelligence community. However, Stacy L. Peerbolte's study of disaster management professionals' CT skills found "no correlation between a participant's score and the dependent variables of age and gender. . . but positive correlation between a participant's score and the independent variables of years of education and years in occupation."[34] The impact between life experience in general versus the years of education and years in occupation warrant additional exploration, as they would indicate a higher level of CT in AWC participants when compared to ACSC participants.

The AF mission requires personnel capable of recognizing personal thought processes and making structured and reasoned analysis to reach decisions. Research supports that the AF can purposely develop CT, meeting the AF FOC's requirements.[35] Programs supporting CT development already existed around the AF in limited capacity, but these programs were typically limited to a particular set of career fields.[36] A structured holistic approach will be critical to integrate CT improvement programs into several forms of PME, both officer and enlisted. In building CT into PME curriculum, it would be desirable to measure CT objectively through a validated survey instrument and to educate faculty and mentors on educational processes for fostering CT skills.

Considerations when building the critical thinking program. Multiple programs already existed across academia to build CT skills in various disciplines such as organization leadership and nursing, with several organizations publishing outlines of the training programs as well as results. Linda Kiltz assessed "to develop critical thinking skills, students must be active learners in the learning process and they must be required to identify and solve unstructured problems using multiple information sources."[37] Paul and Elder even identified 10 intellectual standards, eight elements of reasoning, and eight intellectual traits, ultimately developing 35 dimensions of critical thought.[38] In essence, the AF needs to apply structured problem solving at PME to develop CT, generating warfighters able to operate more effectively in an ambiguous environment.

The NCECT has provided tailored CT development programs to schools and businesses for more than 30 years. Emphasizing the need for long-term sustained devel-

opment of CT, business programs tended to consist of five two-day seminars covering the topics of: (1) recognizing the importance of CT, (2) using the tools of CT to make better decisions, (3) understanding the barriers to CT, (4) learning the art of analysis, and (5) learning the art of assessing thought.[39] The program "clarif[ies] what is meant by the concept of critical thinking and develop[s] practical ways to infuse critical thought into our professional work both individually and institutionally."[40] NCECT's website offered additional course structures for consideration in either building an organization's own CT program or hiring a team to visit the site and conduct the training.

Based on various searches through the AU portal, as well as ProQuest and EBSCOhost, very limited publicly available information suggested possible CT programs already in existence across the AF.[41] The Army shared the concern of poor development in CT skills and claimed CT was a vital component of effective mission command.[42] Likewise, a review of Army PME did not reveal programs specifically designed to develop CT skills. Although the AF repeatedly recognized the need for CT development, no single program existed that supported a sustained education as required in the AF FOC or as detailed by NCECT.

Understanding the concept of CT and the composite skills does not effectively transition to a general awareness of an individual's flawed decision-making. Convincing Airmen that they need to improve their methods and models is a difficult task. People will typically "remain convinced that what they are doing is satisfactory. Further, outsiders who attempt to induce change face opposition. . . "[43] Considering potential application through PME, Paul discovered three disturbing trends in an assessment of CT across multiple civilian educational institutions:

1. Most college faculty at all levels lack a substantive concept of critical thinking.
2. Most college faculty [do not] realize that they lack a substantive concept of critical thinking, believe that they sufficiently understand it, and assume they are already teaching students it.
3. Lecture, rote memorization, and (largely ineffective) short-term study habits are still the norm in college instruction and learning today.[44]

In short, a successful CT development program will require senior leadership's understanding and continued support.

In summary, CT is an obvious fit with PME and the operational AF as it is about problem solving in ambiguous situations. PME offers unique opportunities in that Airmen participate in various forms of in-residence and distance learning programs at multiple points across a career.[45] CT cannot just be a matter of an introductory course at the first PME, but be integrated intentionally throughout the PME curriculum in a holistic fashion. Finally, the AF should formally assess CT at each level of PME throughout an Airman's career to determine whether the programs are effective.

Methodology

My purpose was to identify the current state of CT skills among ACSC, SAASS, and AWC students to create a baseline, and, using a series of t-tests, determine any

statistically significant differences between the three samples of students. This section covers the details of the populations used for the study, data collection, and data analysis.

Population and Sample

The intended population was AD AF officers, field grade or above, attending ACSC, SAASS, and AWC during AY16.[46] The convenience sample ($n = 133$) is detailed in Table 2.

Table 2. Participation by school

	AD AF population	AD AF participants	Percentage of participation
ACSC	295	82	28
SAASS	36	13	36
AWC	92	38	41
Total	423	133	31

The AF sends officers to schools such as ACSC and AWC if the officers' records are in the top 20 percent of a given year group. SAASS is a highly competitive advanced studies program available to officers as they complete an IDE program, such as ACSC. The three schools do not screen for CT skills specifically as consideration for attendance. The research design sampled the students when they were between three and four months into the academic programs. Conducting data collection this far into a one-year program precluded the option of a pretest and posttest assessment, exploring whether the schools developed CT skills within the course of the year. The schools' curriculums convey fundamental concepts of CT; however, none of the schools has specific programs or courses designed specifically to build CT skills. While the results of this study can only be generalized to the top 20 percent of AD AF officers, the lack of any CT screening as a prerequisite would suggest that the rest of the AD AF officer population would likely have the same or lower average scores, but not higher.[47]

ACSC and SAASS students participated in the study on a strictly voluntary basis. While highly encouraged, AWC student participation was also voluntary. Due to the small size and heavy workload of SAASS, the dean solicited volunteers who then received the link to take the appraisal at their convenience. I selected potential participants from ACSC and AWC through a simple random sampling with replacement[48] and reclaimed expired instruments as individuals chose not to take the assessment. I conducted three rounds of data collection for ACSC and two rounds of data for AWC to collect a sufficient sample.

Results

The results of this research provided a starting point for data-driven decision making regarding the integration of CT into PME as well as the operational AF to

meet the AF FOC's requirements. I compared the independent variable of school affiliation (ACSC, SAASS, or AWC) to determine if there were statistically significant differences in the WGCTA scores across the three populations as well as the overall score. My research design applied descriptive statistics and t-tests to analyze the data. Table 3 identifies the mean, standard deviation, and percentile ranking, as well as minimum and maximum scores for each school. The percentile ranking was a comparison between the scores of the population compared to the graduate degree normative group, consisting of "working adults from various industries, occupations, and organizational levels who share a common level of completed education. . . the samples are not limited to students or recent graduates."[49] The graduate degree normative group consisted of 2,321 participants ranging across 38 occupations to include entry-level positions, government service, and executive leadership.[50]

Table 3. WGCTA descriptive statistics

	Mean	Standard deviation	Percentile	Mininum score	Maximum score
ACSC	27.07	6.100	36	13	38
SAASS	30.92	4.958	61	21	36
AWC	27.42	6.664	36	13	38

The t-test is an inferential statistical test "used to determine whether two means are significantly different at a selected probability level."[51] The t-tests explored any differences between (1) ACSC and AWC, (2) ACSC and SAASS, and (3) AWC and SAASS. While there were several small differences between the results of the three schools, only the difference between ACSC and SAASS was statistically significant based on a probability level of 0.05. The abbreviated results for all three t-tests are in table 4.

Table 4. Abbreviated results of t-tests for ACSC, SAASS, and AWC WGCTA scores

		Levene's test for equality of variances		T-test for equality of means			
		F	Sig.	T	Sig. (2-tailed)	Mean difference	Standard error difference
Comparisons	ACSC-AWC	.076	.783	-.282	.778	-.348	1.233
	ACSC-SAASS	1.076	.286	-2.162	**.033**	-3.850	1.781
	AWC-SAASS	1.087	.302	-1.733	.089	-3.502	2.021

Note: difference considered significant (sig.) if it fell below the .05 threshold in the grey column.

Admittedly, an analysis of variance (ANOVA) is the more accurate test for a difference between the scores of three or more populations; however, I went with a series

of t-tests as my primary methodology because: (1) the comparison of ACSC and AWC was the primary focus of the research, and (2) the extremely small population of the SAASS students would not be the most reliable indicator. When I ran the ANOVA on the data set, there was still very heavy overlap in the scores of ACSC and AWC; however, the difference between ACSC and SAASS was only approaching significance with a value of .055. Additionally, the post hoc test for the ANOVA was at .725, falling below the preferred value of .8. While there are several ways to calculate the desired sample size, I certainly would have preferred a larger sample to improve the power analysis; however, sampling roughly 30 percent of each population, as reported in table 1, still served as an excellent point of departure for future research opportunities (see Areas for Further Research). While I wanted a greater sample size, and I could test the data in a couple of different ways, every way I analyzed the data showed almost no difference in the CT skills of AWC and ACSC students.

The results as plotted on a histogram (see figure 1) suggested an even distribution without significant kurtosis but with a slightly negative skew.[52] As identified in table 3, ACSC and AWC had very similar mean scores, minimum and maximum scores, and standard deviations. SAASS had a higher mean score, less range between the minimum and maximum scores, and the smallest standard deviation among the three schools.

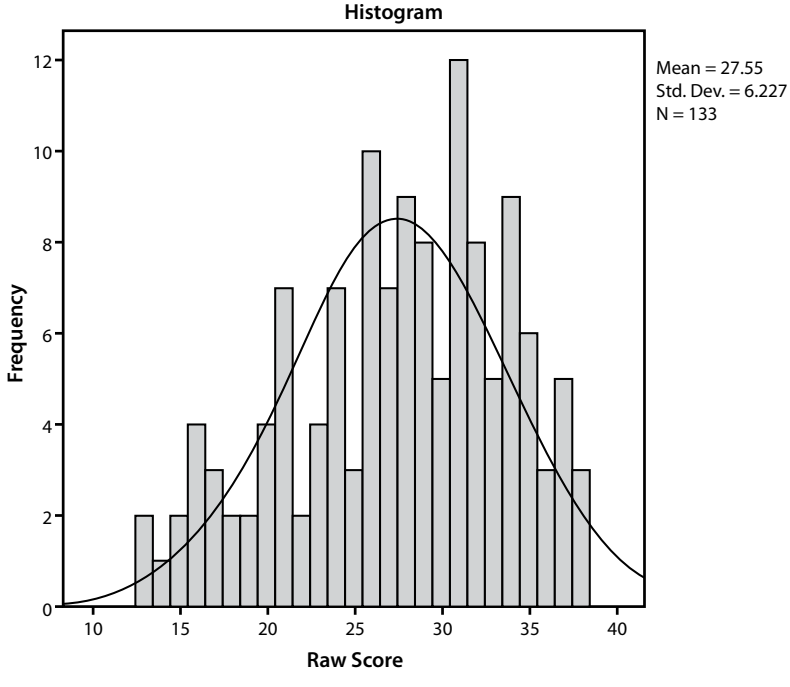

Figure 1. Distribution of raw WGCTA scores for ACSC, SAASS, and AWC (combined)

Discussion

Applying t-tests and basic descriptive statistics, the data supported the null hypothesis that there was no statistically significant difference in the CT skills of AD AF students attending the in-residence ACSC and AWC programs in AY16. More specifically, there was no statistically significant difference between the total scores or across the three individual skills of (1) recognizing assumptions, (2) evaluating arguments, and (3) drawing conclusions. However, SAASS scored significantly higher than ACSC per the t-test and reflected the smallest standard deviation across the schools. The results plotted as a normal distribution without noteworthy kurtosis and a slight negative skew. The average scores of the ACSC and AWC students both ranked at the 36th percentile when compared to the graduate degree normative group.

Implications

In accordance with the AF FOC, CT is vitally important to the success of the AF. ACSC and AWC are a sample of the top 20 percent of officers by their very selection to attend IDE or SDE in-residence. The analysis indicated the top 20 percent of AF officers at the field grade officer-level were below average critical thinkers. The methodology presented provides the AF and DOD with a way to quantitatively measure CT, establish a baseline for military personnel, and implement an educational program where improvements in CT can be clearly measured and sustained. This research does not stop with the small portion of the AF surveyed in the research. Additional research must explore building the CT skills of the junior enlisted and officers executing the tactical mission. The AF cannot afford to consider CT as an expectation or privilege for the senior leadership; it is vital for every Airman to begin or continue the lifelong pursuit of being a critical thinker.

Successful CT programs require strong critical thinkers on the faculty. Although not a sufficient sample size, six CT enthusiasts from AU faculty and leadership volunteered to take the WGCTA as well. The average raw score for all participants was 31.67; however, when considering the possibility of building a CT program, the lower two scores of 25 and 27 would be excluded, resulting in an average raw score for the remaining four of 34.5. The new average placed the four participants in the 86th percentile, higher than that observed with the SAASS students, and suggested the talent was already in place to enhance CT integration for all three schools. These numbers only indicated a potential, and a complete assessment will be required before identifying the right personnel to build a CT development program.

Based on the literature review and the results, the AF needs to implement a CT development program, starting with faculty at ACSC and AWC. This will require first identifying the strongest critical thinkers as assessed by the WGCTA, giving them the time and resources to create a modified series of seminars derived from the NCECT's recommended program, and then begin sessions with all ACSC and AWC faculty to improve CT over a three-month period with quarterly sessions after that. The next phase will entail applying those skills to the in-class discussions through a combination of integrating the faculty program materials into the instruction and weaving measurable CT requirements into the syllabi by modifying existing

case studies and exercises in-line with Kiltz's observations.[53] CT should not be a stand-alone block of instruction early in the academic year but a periodic and recurring enhancement throughout the program. The faculty should make their CT development program available to the rest of the AF as a baseline, and the graduates will take their CT skills out to the operational AF, holding their personnel accountable to higher standards and further integrating CT. For AWC and ACSC, the recommended program is not a matter of determining what material to remove from the courses to accommodate a CT program. Rather, it is how to improve the delivery of the existing materials in a manner that fosters CT development.

Areas for Further Research

To explore whether PME improves CT, I recommend either a longitudinal study or a pretest and posttest method. A longitudinal study to track accessions throughout a career would be a valuable and pure comparison but would admittedly be difficult to execute. Higher headquarters endorsement would also help future researchers achieve the higher sample percentages of the target populations to increase the accuracy of the results. Considering the complete lack of significant difference between ACSC and AWC, coupled with previous analysis between junior and mid-level AF intelligence officers,[54] additional research could explore whether the CT skills of SOS students or even accessions and technical school students score any differently. Such a project would be the first study expanding beyond a boarded population and would provide a baseline for the general AF population. The AU command chief reinforced the AF FOC and recommended the AF should ensure *all* Airmen, including the enlisted 80 percent of the force, have the tools to refine their CT skills continuously.[55] For all the recommended studies above, future research should collect additional demographic data to look for additional trends to include AFSC, the level of education, schools attended (e.g., brick and mortar, online, night school), and degrees held. Complementing these quantitative studies, qualitative research should explore opportunities to integrate CT into PME more effectively, both officer and enlisted, and identify specific methods to integrate CT into the operational AF.

Conclusion

AD AF students attending ACSC and AWC during AY2016 collectively scored at the 36th percentile when compared to the graduate degree normative group. This supported the hypothesis that there was no statistically significant difference between the CT skills of ACSC and AWC AD AF students. Through a series of t-tests, the null hypothesis was accepted; however, the analysis also supported the hypothesis H_b with the statistically significant difference in scores between SAASS and ACSC.

This research was the first of its kind, establishing a baseline against which the AF could assess the current state of CT skills among AD AF officers. The methodology was also exportable to the rest of DOD for other services determined to identify and build critical thinkers. Interested organizations in the AF can also apply the methodology to examine the development of CT skills over time, identify best practices, and continue to refine the organization's approach. The AF can measure and

improve CT skills across the force by starting with a faculty program at ACSC and AWC, ultimately ensuring a continuous emphasis on CT in both PME and the operational AF. ✪

Notes

1. *Air Force Future Operating Concept: A View of the Air Force in 2035*, September 2015, http://www.af.mil/Portals/1/images/airpower/AFFOC.pdf, 12.

2. Lt Gen Steven L. Kwast, "Welcome to the Air University," Air University homepage, accessed 27 September 2015, http://www.au.af.mil/au/. AU provided an excellent point of departure with the stated goal to "cultivat[e] adaptive, critical thinkers. . . crucial to security, both here and abroad."

3. Lyndon McKown, "Improving Leadership through Better Decision Making: Fostering Critical Thinking" (master's thesis, Air Command and Staff College, 1997); and George Emilio, "Promoting Critical Thinking in Professional Military Education" (master's thesis, Air Command and Staff College, 2000), 2.

4. Emilio, "Promoting Critical Thinking"; McKown, "Improving Leadership"; and David T. Moore, *Critical Thinking and Intelligence Analysis* (Washington, DC: Joint Military Intelligence College, 2006).

5. Air Force Doctrine Document 1–1, *Leadership and Force Development*, 8 November 2011, 39, http://static.e-publishing.af.mil/production/1/af_cv/publication/afdd1-1/afdd1-1.pdf.

6. McKown, "Improving Leadership," 5–9; and Moore, *Critical Thinking,* 8–14.

7. National Council for Excellence in Critical Thinking, "Defining Critical Thinking," accessed 22 January 2016, http://www.criticalthinking.org/pages/defining-critical-thinking/766.

8. Richard Paul and Linda Elder, *The Miniature Guide to Critical Thinking Concepts and Tools*, 4th Edition (Dillon Bay, CA: The Foundation for Critical Thinking, 2004), 4.

9. Lewis Vaughn, *The Power of Critical Thinking: Effective Reasoning about Ordinary and Extraordinary Claims* (New York: Oxford University Press, 2005), 4.

10. Goodwin Watson and Edward M. Glaser, *Watson-Glaser Critical Thinking Appraisal: Manual* (San Antonio, TX: Psychological Corporation, 1980), 1.

11. Based on anecdotal evidence derived from multiple conversations between the author and various officer, enlisted, and civilian personnel in the last 10 years. There is the possibility that the AF Future Operating Concept would be better served with a term less restrictive than CT since it technically excludes some of these other valuable forms of thinking.

12. Richard Paul and Linda Elder, *Critical Thinking: Tools for Taking Charge of Your Professional and Personal Life*, 2nd Edition (Upper Saddle River, NJ: Pearson Education, Inc., 2014), 363.

13. For example: (1) the Cornell Critical Thinking Test, (2) the Ennis-Weir Critical Thinking Essay Test, (3) the New Jersey Test of Reasoning Skills, (4) the California Critical Thinking Skills Test, and (5) the WGCTA.

14. Roxanne Fall, "Intuitive Abilities: A Comparison between Police and Non-Police Individuals" (PhD diss., The Union Institute Graduate College, 2002), 36; and Goodwin Watson and Edward M. Glaser, *Watson-Glaser Critical Thinking Appraisal: Manual*, 10–13.

15. Linda Kiltz, "Developing Critical Thinking Skills in Homeland Security and Emergency Management Courses," *Journal of Homeland Security and Emergency Management*, 6, issue 1, article 36 (January 2009), DOI: 10.2202/1547-7355.1558; Peter Behrens, "The Watson-Glaser Critical Thinking Appraisal and Academic Performance of Diploma School Students," *Journal of Nursing Education* 35, no. 1 (January 1996); María E. Valdés-Corbeil, "The Effect of the Watson-Glaser Critical Thinking Appraisal Test Preparation Program on the Critical Thinking of Teacher Education Program Applicants," (PhD diss., University of Houston, 2005); and Adam J. Stone, "Critical Thinking Skills of Air Force Intelligence Officers: Are We Developing Better Critical Thinkers?" (master's thesis, National Defense Intelligence College, 2008).

16. Watson and Glaser, *Critical Thinking Appraisal*, 4.

17. Ibid., 10; Bernadette Gadzella et al., "Reliability and Validity of the Watson-Glaser Critical Thinking Appraisal-Forms for Different Academic Groups," *Journal of Instructional Psychology* 33, no. 2 (June 2006); Diane Wilson and Edwin Wagner, "The Watson-Glaser Critical Thinking Appraisal as a Predictor of Performance in a Critical Thinking Course," *Educational and Psychological Measurement* 41

(1981); and Robert Loo and Karran Thorpe, "A Psychometric Investigation of Scores on the Watson-Glaser Critical Thinking Appraisal New Form S," *Educational and Psychological Measurement* 59, no. 6 (December 1999).

18. Goodwin Watson and Edward M. Glaser, *Watson-Glaser II Critical Thinking Appraisal: Technical Manual and User's Guide* (Bloomington, MN: NCS Pearson, Inc, 2010), 18.

19. Goodwin Watson and Edward M. Glaser, *Watson-Glaser II Forms D & E Critical Thinking Appraisal: Norms Composition Tables* (Bloomington, MN: NCS Pearson, Inc, 2014), 4.

20. Bernadette Gadzella et al., "Reliability and Validity of the Watson-Glaser Critical Thinking Appraisal-Forms for Different Academic Groups," 141; and Watson and Glaser, *Critical Thinking Appraisal*, 10–11.

21. Watson and Glaser, *Critical Thinking Appraisal*, 20.

22. Paul J. Blaskowski, "Producing Better Entry-Level Intelligence Analysts Across the Intelligence Community" (master's thesis, Joint Military Intelligence College, 2005), 94.

23. Richard Paul and Linda Elder, *The Miniature Guide, 4.*

24. Jennifer Reed, "Effect of a Model for Critical Thinking on Student Achievement in Primary Source Document Analysis and Interpretation, Argumentative Reasoning, Critical Thinking Dispositions, and History Content in a Community College History Course" (PhD diss., University of South Florida, 1998), 38.

25. Lois Magnussen, Dianne Ishida, and Joanne Itano, "The Impact of the Use of Inquiry-Based Learning as a Teaching Methodology on the Development of Critical Thinking," *Journal of Nursing Education* 39, no. 8 (November 2000): 360.

26. Laurie Blondy, "A Correlational Study Between the Critical Thinking Skills of Nursing Faculty and Their Perceived Barriers to Teaching Critical Thinking Skills to Nursing Students" (PhD diss., Capella University, 2007), 84.

27. Roxanne Fall, "Intuitive Abilities: A Comparison between Police and Non-Police Individuals," 64.

28. María Valdés-Corbeil, "The Effect of the Watson-Glaser Critical Thinking Appraisal Test Preparation Program on the Critical Thinking of Teacher Education Program Applicants," 91.

29. Richard Paul and Linda Elder, *The Miniature Guide,* 2.

30. Ibid.

31. Jennifer Reed, "Effect of a Model for Critical Thinking on Student Achievement in Primary Source Document Analysis and Interpretation, Argumentative Reasoning, Critical Thinking Dispositions, and History Content in a Community College History Course," 143.

32. Ibid., 160.

33. David T. Moore, *Critical Thinking and Intelligence Analysis*.

34. Stacy L. Peerbolte, "Disaster management and the critical thinking skills of local emergency managers: correlations with age, gender, education, and years in occupation" *Disasters* 37(1) (2013), DOI: 10.1111/j.1467-7717.2012.01291.x: 58.

35. Secretary of the Air Force, *Air Force Future Operating Concept: A View of the Air Force in 2035*, (Washington, DC: Air Force News Service, 15 September 2015), http://www.af.mil/Portals/1/images/airpower/AFFOC.pdf.

36. Emilio, "Promoting Critical Thinking," 23–25; and Moore, *Critical Thinking*, 65. Also reference the advanced analysis mobile training team provided for DOD intelligence professionals and run by Dr. Jon Kimminau in AF/A2D.

37. Linda Kiltz, "Developing Critical Thinking Skills in Homeland Security and Emergency Management Courses," *Journal of Homeland Security and Emergency Management*, 5.

38. Linda Elder and Richard Paul, *Intellectual Standards: The Words that Name them and the Criteria that Define them* (Tomales, CA: *Foundation for Critical Thinking*), 10.

39. National Council for Excellence in Critical Thinking, "Professional Development Workshops," accessed 22 January 2016, http://www.criticalthinking.org/pages/professional-development-workshops-for-business-professional-groups/430.

40. Ibid.

41. AU Portal search looked for any paper with "critical thinking" in the title. Only three papers exist, and the most recent was from 2003. For ProQuest, search focused on any dissertation with "critical thinking" in the title, yielding 32 dissertations meeting the criteria, and no dissertation studied the military. In EBSCOhost, the search focused on any scholarly journal with "critical thinking" in the title

from the Academic Search Premier, Military and Government Collection, and Teacher Reference Center databases. The search yielded 480 results addressing challenges across several different career fields; however, when further limiting the search to any document with "critical thinking" in the title and "military" in the abstract, the search yielded two articles, one focusing on Army medicine and the other focusing on Army Decision Support Red Teams. Follow-on searches substituted each of the services for "military" and yielded no results except for the two already identified for the Army.

42. Col Thomas M. Williams, "Education for Critical Thinking," *Military Review* (January–February 2013), http://usacac.army.mil/CAC2/MilitaryReview/Archives/English/MilitaryReview_20130228_art011.pdf.

43. Moore, *Critical Thinking*, 74.

44. Richard Paul, Linda Elder, and T. Bartell, "California Teacher Preparation for Instruction in Critical Thinking: Research Findings and Policy Recommendations," *California Commission on Teacher Credentialing* (1997). For further context, also see Paul's "The State of Critical Thinking Today," *New Directions for Community Colleges* 2005, issue 130 (14 June 2005), http://www.criticalthinking.org/pages/the-state-of-critical-thinking-today/523.

45. For example: accession, Squadron Officer School, Air Command and Staff College, and Air War College for officers and basic military training, First-Term Airman's Course, Airman Leadership School, Non-Commissioned Officer (NCO) Academy, and Senior NCO Academy for enlisted.

46. The research did not collect data on the guard, reserve, joint, interagency, or international fellows at the schools because the potential sample was insufficient for generalizing to a larger population as well as the challenge of scoping the research. Likewise, the research did not collect additional demographic data regarding career field or sources of previous education because the large number of career fields would prevent any accurate correlations and the previous education consideration was beyond the scope of this foundational study.

47. Adam J. Stone, "Critical Thinking Skills of Air Force Intelligence Officers: Are We Developing Better Critical Thinkers?" In this study, a similar methodology using the WGCTA and comparing to same normative group showed both second lieutenants going through intelligence officer pipeline course and senior captains and junior majors going through the Intelligence Master Skills Course had no statistically significant difference in their CT skills as measured by t-test nor were there any reportable results using a Pearson's *r* to detect any improvement in CT skills based on age. Furthermore, the two samples scored at the 35th percentile when compared to the graduate degree norm group. Although this study was unclassified, the National Intelligence University posts all papers on their TS/SCI JWICS page regardless of classification. If interested in the details of the research, contact the author directly at adam.stone@us.af.mil.

48. The researcher obtained lists of AD AF students, in alphabetical order, attending ACSC and AWC and then provided the e-mail address of every third name to the TalentLens point of contact to send the survey instrument link. When the 12-day period to take the appraisal expired, the researcher coordinated with TalentLens to reclaim expired surveys and start over from the top of the list, again selecting every third name, until a sufficient sample was collected.

49. Goodwin Watson and Edward M. Glaser, *Forms D & E Critical Thinking Appraisal*, 8.

50. Ibid., 8–9.

51. L. R. Gay and Peter Airasian, *Educational Research: Competencies for Analysis and Applications*, 7th ed. (Upper Saddle River, NJ: Prentice Hall, 2003), 457.

52. Figure 1 only displayed the distribution for the entire sample; however, plotting the distribution for the individual schools did not generate any significant visible differences in the normal distribution, kurtosis, or skewness.

53. National Council for Excellence in Critical Thinking, "Professional Development Workshops"; and Kiltz, "Developing Critical Thinking Skills."

54. Stone, "Critical Thinking Skills."

55. CMSgt Timothy B. Horn, interview by the author, 4 December 2015.

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